ENGINEERING BULLETIN

EB005/2020

CLEARANCE CONTROL

One of the most critical variables that determine the success of a performance engine build is bearing clearance (also called oil clearance). In simple terms this is the gap between a bearing and the shaft in which the lubricant maintains separation of the two surfaces. The size of this clearance influences:

1. The generation of very high-pressure oil films that ensure the separation of shaft and bearing. Terminology Note: Oil film thickness is a characteristic often mentioned when considering bearing system operation. This refers to the amount of separation between bearing and journal effected by these high-pressure oil films. While influenced by the clearance these films are generated by the relative motion of the shaft and bearing and the size and direction of transmitted load. In general, `oil film thickness' is significantly smaller than the nominal `clearance'.
2. The flow of lubricant which provides essential cooling.
3. The generation of lubricant supply pressure ensuring even distribution throughout the engine.

These requirements can be contradictory in terms of clearance. Specifically, an increase in clearance can increase lubricant flow, and therefore cooling, but will generally reduce the ability to form extensive high-pressure oil films and therefore support operating loads. In general, clearance control is a skilful balance between allowing sufficient gap to ensure adequate oil flow and a close fit that encourages extensive high-pressure oil films to support operating loads.

BEARING SIZE OPTIONS

In order to help the performance engine-builder optimise clearances for their particular engine application, ACL provides a range of three bearing sizes for standard (STD) crankshaft journal sizes. These are:

SIZE	Effect on clearance (when used as pairs)
H-STD	Bearing thickness is precision finished to provide a nominal clearance based on OEM specifications and ACL Race Series proven design standards.
HX-STD	Providing an extra .001" (0.025mm) of clearance over the H-STD size bearings.
H-001 / H-.025	Providing a reduction of .001" (0.025mm) of clearance over the H-STD size bearings.

ACL RACE SERIES

PERFORMANCE ENGINE BEARINGS

GUIDELINES FOR BEARING SIZE SELECTION AND OPTIMISING CLEARANCES

The guidelines below are intended to provide the engine builder with generalised starting points with regards to the selection of appropriate oil clearance. Although a significant influence, the clearance is only one of many variables that determine system robustness (oil viscosity, load cycles and operating temperatures are some others*). Accordingly, the engine builder is advised to understand all factors in determining an appropriate clearance.

ACL's approach is to provide the engine builder with tough, adaptable bearings precision finished to exacting thickness specifications. Combined with the sizing options above this allows the performance engine builder to bring their skills and knowledge to bear when optimising clearances for the desired end use.

① SETTING CLEARANCES

Oil clearances are most accurately measured using micrometers and bore gauges.

Bearing wall thickness measurements are taken at 90 degrees to the parting line (i.e. at the crown of the bearing) using a micrometer with a ball anvil, for use on the curved ID of the bearing.

Vertical oil clearance is best measured by assembling the bearing in its housing, with bolts torqued to specification, then using a bore gauge measure the assembled ID of the bearings at 90 degrees to the parting faces. The mating crankshaft journal size is measured and subtracting this measurement from the bearing ID bore size gives the assembled oil clearance.

Assembled clearance can be confirmed using ACL Flexigauge (see ACL Engineering Bulletin EB003/2016).

ACL Race Series performance engine bearings can be assembled with .00075-.001" per 1" of journal diameter (0.020-0.025mm per 25mm of journal diameter) plus .0005" (0.013mm).

As an example: for a 2.000" (50mm) journal diameter, 2.000 x .001 = .002 + .0005 =.0025" (50/25 x 0.025 = 0.050 + .013 = 0.063mm).

Bearings should not be polished with abrasive pads or paper, on the bearing surface, to change the oil clearance.

2 SELECTION OF ACL RACE SERIES PERFORMANCE ENGINE BEARINGS FOR STANDARD SIZE CRANKSHAFTS

Below are some broad guidelines for the fitment of STD, HX and .001 bearing sizes.

SIZE	Usage
H-STD	Suitable for all applications using crankshafts finished to OEM specifications.
HX-STD	Suitable for high to extreme power applications where additional clearance is beneficial in providing: • Additional oil flow through the bearings to both improve delivery to high load zones and enhancing cooling. • Allowing for increased housing distortion under very high inertial and firing loads. • Allowing for increased flexing of the crankshaft under high load operation. • Providing space for specialised anti-friction coatings that beneficially moderated bearing to shaft surface interactions.
H-001 / H-.025	Suitable for adjusting clearance to compensate for: • Surface reconditioning (polishing) of crankshaft journals. • The use of low viscosity lubricants. Without reducing clearance, the use of low viscosity lubricants will result in more concentrated, higher pressure oil films with reduced oil film thickness. This approach, however, should be tackled with caution as the reduced clearance also reduces allowance for housing distortion and crankshaft flexing under high load operation.

3 SELECT FITTING OF ACL RACE SERIES PERFORMANCE ENGINE BEARINGS

It is common practise to adjust oil clearances by mixing bearings of adjacent grades i.e. HX-STD with H-STD or H-STD with H-001 or H-0.025, to obtain desired oil clearance. Using the HX-STD with H-STD will give .0005" (0.013mm) additional clearance than using two H-STD shells, and similarly using H-STD and H-001 will reduce clearance .0005" (0.013mm). This, in effect provides the engine builder with 5 potential clearance grades* of 0.0005" (0.013mm) increments. The table on the back page demonstrates this in more detail.

Bearing shells with wall size .0005" (0.013mm) or less can be assembled on one journal. The thicker wall size bearing should be fitted to the highest loaded position i.e. the upper half con rod shell and the lower half or cap position main bearing.

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EFFECT ON CLEARANCE

*Note: OEMs often specify the selection of graded size bearings based on individually measured housing and journal sizes. This allows close control of clearance sizes in a similar manner to the options described above. The reasons for close clearance control by OEMs is often determined by noise transmission effects within the engine, a factor that is generally of little concern to performance engine builders. As OEM specifications are determined for operating conditions circumscribed by `red line' speeds and moderate loads, OEM recommended clearances are not necessarily optimised for high load, high speed performance applications.

Selecting Bearings for the Optimized Fit (for "STD' sized crankshaft)

BEARING SIZE	Effects on Clearance				
	Per Bearing	Bearing Combinations			
		Matched Pairs		Mixed Pairs	
H-001 / H-.025	-.0005∫ / -0.0125mm	H-001 / H-.025	-.001∫ / -0.0250mm		
		H-001 / H-.025		H-001 / H-.025	-.0005∫ / -0.0125mm
H-STD	0.0	H-STD	0.0	H-STD	
		H-STD		H-STD	+.0005∫ / +0.0125mm
HX-STD	+.0005∫ / +0.0125mm	HX-STD	+.001∫ / +0.0250mm	HX-STD	
		HX-STD			